Quality of Service Parameter Measurements Data Analysis in the Scope of Net Neutrality

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Abstract— A lot of new applications and services come into use thanks to widely available broadband access and high quality of service parameter values for broadband networks. As broadband access technologies develop and competition between different services becomes higher the need for addition regulation, for different services to coexist on equal terms, becomes necessary. As a result, net neutrality principles were introduced, which aim is to allow all services to ensure that there is no traffic discrimination on the internet. In the European Union European Commission developed regulation for net neutrality, providing basic net neutrality principles to be respected and implemented in all European countries. Outside Europe net neutrality question is also actual and is actively discussed and measures are taken to ensure that neutrality principles are implemented. Still many question regarding new regulation in net neutrality stay open. One of them is quality of service in scope of net neutrality. New regulation defines specific internet access services parameters of speeds to be measured and analysed for fixed and mobile networks. Those parameters include minimum, maximum, normally available and advertised speed for fixed broadband networks, and estimated maximum and advertised speed for mobile broadband networks. Regulation provides examples, but does not define the exact measurement and result analysis options most suitable for different measurement scenarios in fixed or mobile network As one of the corresponding projects — mapping of broadband service parameters when measurement results are visualised on map, is very actual, mapping options should also be considered, and to ensure that mapping for all countries measured parameters is united, and measurements are made and proceeded in the same manner in all countries. So, the way the network speed parameters are analysed and proceeded are very important also in the mapping context. Different scenarios of network parameter measurement result distribution are possible. As relevant regulations define specific parameters that should be measured, it is necessary to understand, and then implement very accurate and most suitable data analysis, taking into account different data distribution scenarios, to determine correct result. The main objective of this investigation is to determine analysis options and to choose optimal measurement samples of the quality of service parameters for the further analysis in the context of net neutrality principles providing united measurement and measurement result analysis methodology.

1. INTRODUCTION

Net neutrality is a principle that all traffic on the Internet should be treated equally. The principles of Net neutrality are widely discussed and implemented in different world countries. For European Union countries one of the important steps to ensure Net Neutrality rule adaptation was introduction of REGULATION (EU) 2015/2120, which main functions are to safeguard equal and non-discriminatory treatment of traffic, protect end-users and guarantee the continued functioning of the internet ecosystem as an engine of innovation. As well the Regulation does not define the methods of implementation of the net neutrality rules, BEREC introduced Guidelines (BoR (16) 127) to help European countries interpret and adopt the rules of the Regulation [3, 9, 10].

One of the important parts of the Regulation is surveillance of transparency requirements and Information indicated in the contracts, where one of the most important aspects for end-users is quality of service, specifically upload and download speed. The Regulation defines specific parameters that should be measured and analysed, but does not define the united data analysis principle.

Broadband service mapping describes systems that gather, analyse and present information on the supply side of broadband service provision including the available bandwidths (speed), technologies, operators/service providers and quality of service in a specific area. Service mapping can be conducted to create an insight into the current state of broadband availability. As a result, the need and best option for implementation of new broadband internet access technologies in different regions can be evaluated and after that implemented in the best way. United analysis

methodology is important for all countries, as EU mapping project also takes place and data are gathered from different European countries for one mapping project, showing similar measurement and measurement data analysis results.

In this paper authors offer the way, to analyse measured internet access quality of service parameters according to Regulation, and provide an example of mapping for a specific region.

2. DATA ANALYSIS OF QUALITY OF SERVICE PARAMETERS

For objective measurement representation, obtained data should be comparable and plausible, so it is important to use one measurement system and analyze the received data in one way.

For measurement purposes and experiment the Visualware MyConnection Server tools measurement system was used [1]. The measurements were made in different geographical locations, and for the comparable results the fixed and the mobile network internet access parameters were measured.

To obtain comparable results data measurements are performed in the same conditions for all operator networks. Quality parameters such as upload and download speed, latency, jitter and packet loss ratio are measured. Later all data is analysed and validated. Measurement data which is deemed to be implausible, is discarded.

After validation measurement data is sorted depending on measurement location and operator. Usually the average value of each parameter is calculated and represented according to measurement location and mobile operator.

To abide Net neutrality rules measured data should be analyzed according to the Regulation and the Guidelines. Guidelines define that parameters, that should be calculated and evaluated are average speed, minimal speed, maximum speed and normally available speed. In this paper authors used download speed measurement series to provide an example of data analysis methodology, but the same method can be used to for upload speed data analysis.

The first step for measurement data analysis is data gathering. Data can be gathering using different measurement systems, but it is preferable that united measurement tool for data that will be represented in one report is used.

The second step would be data validation and discharging of the implausible data.

For experimental purposes, the measurement series for different fixed and mobile networks were conducted and examples of the measurement results for Download speed.

In the Figure 1, the example of separate measurement in specific times before data analysis for fixed network can be seen. As can be seen form the measurement results, download speed for fixed network is stable most of the time, and measurement separate values difference is usually not very big ($< 30\%$ for measured fixed networks).

In the Figure 2, the example of separate measurement in specific times before data analysis for mobile network can be seen. As can be seen form the measurement results, download speed for mobile network is stable most of the time, and measurement separate values difference is more noticeable than in fixed networks.

As can be seen from Figures 1 and 2, the Quality of service (QoS) values and their distribution differ depending on a measurement time and a network type. It very important to make specific data analysis, that would be suitable for every measurement distribution scenario.

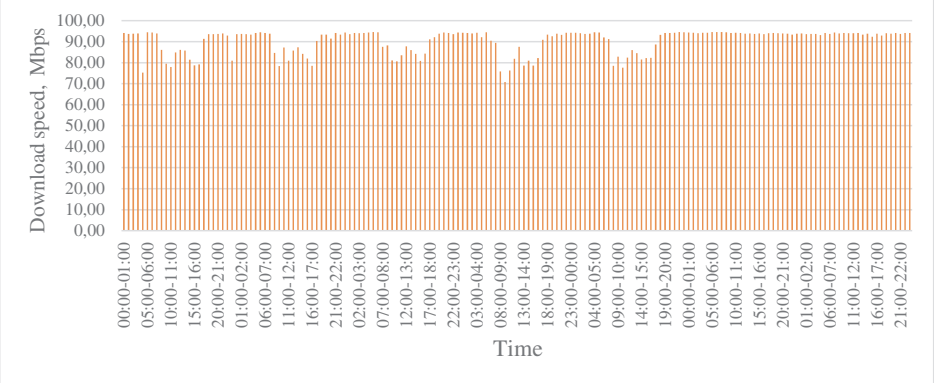

Figure 1: Example of a separate measurements for fixed network.

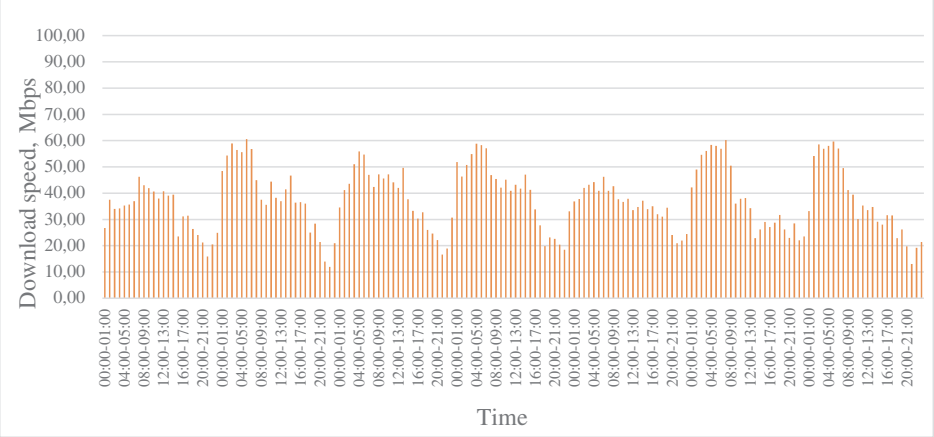

Figure 2: Example of a separate measurements for mobile network.

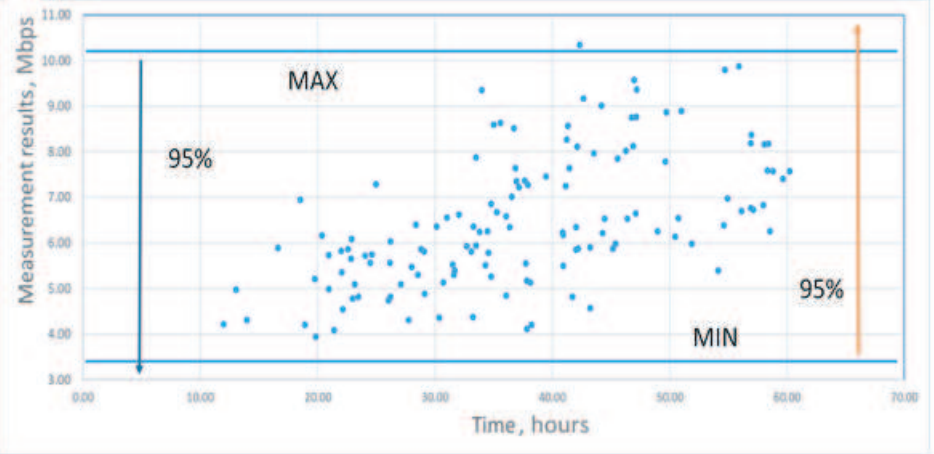

Figure 3: Example of measurement value distribution and graphical representation of taken 95% of values.

The third step in data analysis, that would provide the most specific and reliable result, which would later provide more realistic requirements for operators, is data filtering, to get rid of the 5% of minimum or maximum values of the measurements. As measurement period is usually long, may even be a year long, it is crucial not to take into account measurement results that are very small or big and occur very rarely, e.g., five times a year. Measurement filtering allows make a regulation which does not set inadequate requirements for the operators, e.g., provide maximum speed, that is in fact physically available once a month, every day at least one time. The same goes for minimal values, where only one very bad measurement result can worsen the whole analysis results badly. As an result end-users make judgement comparing the end results of the analysis, not taking into account the frequency of specific measuremet results.

For data analysis measurement data results are filtered by taking into acount 95% of the measurement results for minimum and maximum speeds. 95% of the measuremets are taken by casting aside and not using the 5% of the measurements of minimum or maximum speeds in the further calculations.

Graphical representation of the data filtering is shown in the Figure 3, where with the dots separate measuremet results are shown and MIN and MAX indcate minimum and maximum level, that cuts off 5% of the measurement results from each side.

For the calculation of the average parameter the is no need to filter the 5% of data, as in the case of minimum and maximum speeds, because each minimum and maximum value are taken into account and represent not the best of worst result, but one that can be considered to be normally available.

As a result of the analysis counted values can be used to set requirements for network operators, to provide information to end-users and these values can be also used as the value defined in the

agreement between network operator and end-user, as it is set by Regulation requirements.

An example of maximum and minimum values for a specific measurement case, with and without filtering the 95% of data, is shown in Figure 4.

Network	Maximum, Kbps	Max 95%, Kbps	Minimum, Kbps	Min 95%, Kbps	Median, Kbps
Fixed	94682.9	94610.09	1624.74	72460.065	93417.14
Mobile	98657.22	66097.139	1170.66	13413.832	37154.70

Figure 4: Table with the example of data analysis results for fixed and mobile network.

It can be seen from the Figure 4, that taking only 95% of the measurement results by filtering accident measurement data, can influence the analysis result. That can be seen comparing the filtered and not filtered data. On the mobile network example this fact is more visible. For stable fixed networks, where download speed was more stable there is very small difference between maximum value with and without filtering, but for non-stable mobile network, difference in measurements is more noticeable. The opposite goes for minimum value, where in the stable fixed network small value is rare, but in mobile network smaller values are more common. It can also be seen by countinting the median, where for fixed network median value is closer to the maximum value, and in the case of mobile network to the minimum value. So, it is more rational to determine the minimum and maximum parameter value based not on the one time measurement result, but on the filtered results.

Provided Quality of Service parameter measurements data analysis can be used for different cases and corresponds with Net neutrality principles.

3. MEASUREMENT DATA REPRESENTATION ON MAP

One of the ongoing EU projects, that corresponds with the new net neutrality regulation is the mapping project [2, 4–6].

Measurement results are represented in National initiative's mapping application as a point on the map, and the points are colored according to the speed categories.

In the scope of net neutrality quality parameter measurements should be understandable, comparable and be available to users [7, 8]. The most accessible way to make measurements more understandable and easily comparable is their representation on the map. An example of mapped measurement parameters is shown in Figure 5. For each geographical point measurements are collected, then analysed and calculated and in result represented on the map.

Regulation should be united, so the use of united measurement, data analysis and mapping systems is preferable [11].

In the previous paragraph provided data analysis option is, in authors opinion, the best options to calculate and analyse the data for the mapping project purposes. Calculated values can be used for any mapping representation approach, where by this methodology any amount of data for any period of time can be calculated, analysed and represented on map.

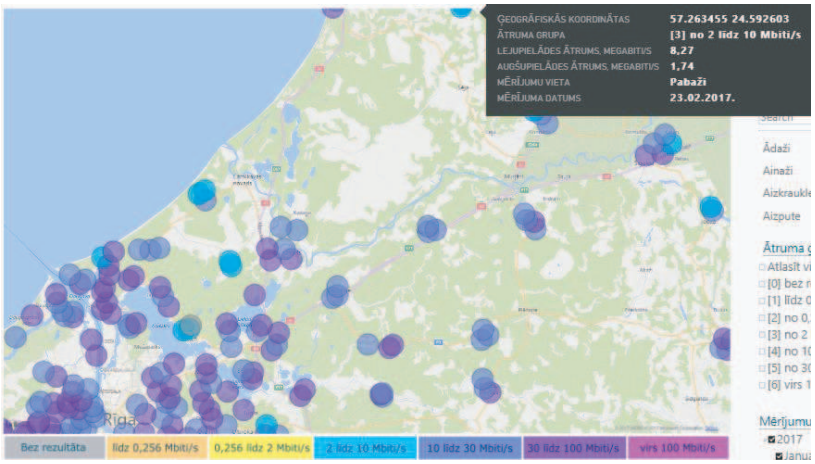

Figure 5: Example of the map representing measurement results for different geographical locations after data analysis.

4. CONCLUSION

Comparing different data analysing approaches it can conclude that to get the data that are comparable, objective and can be used in most situation the approach, where data filtering is used is the most suitable for different use cases. This Quality of Service parameter measurements data analysis is developed according to the Net neutrality principles of the European regulation and takes into account end-user and network operator interests.

Results gotten using mentioned data analysis can be used for interferent access quality parameter mapping, agreements and surveillance purposes. Mentioned data analysis is applicable for any amount of data and any measurement period.

Additional conclusions were also made. Comparing the data gotten by measuring and analyzing fixed and mobile networks separately, it can be concluded that for fixed network, which are stable and download speed is mostly high, data filtering impact the minimum speed the most, but for mobile networks the situation is completely opposite, as the impact is on the maximum speed value is more obvious. It is a result of network structures, where in the constant fixed network data stream very small download speed is very rare, but can be very low. In mobile networks, where speed is dependent on the network capacity and number of end-users download speed is not stable and if the number of end-users is high then one end user gets very high speed rarely.

In the future perspective, each new broadband internet access mapping data, calculated and analysed using described methodology, could be added as an addition layer over the existing mapping data, providing opportunity to compare information of different periods in each region or operator, taking into account the net neutrality principles.

REFERENCES

1. Visualware Inc., Available at http://www.visualware.com.
2. Arnond, A., M. Kirch, M. Waldbunger, and A. Windolph, *Study on Broadband and Infrastructure Mapping*, Berlin, Germany, 2012, 30-CE-0555114/00-17 SMART 2012/0022.
3. Marsden, C., *Net Neutrality: Measuring the Problem, Assessing the Legal Risks*, Barcelona, January 2014, ISSN: 1886-2802.
4. Lipenbergs, E., A. Stafecka, G. Ivanovs, and I. Smirnova, "Quality of service measurements and service mapping for the mobile internet access," *2017 Progress In Electromagnetic Research Symposium (PIERS)*, Russia, St Petersburg, 2017.
5. "Framework and methodology for ITU world terrestrial transmission map project," March 3, 2013.
6. Bohlin, E., S. Forge, S. Lindmark, R. Horvitz, and C. Blackman, "SMART 2016/0046 study on fixed and mobile convergence in Europe," *Workshop Broadband Mapping Smart 2014–2016 Meeting*, DG CNCT Brussels, December 12–13, 2016.
7. "Directive 2002/22/EC of the European Parliament and of the Council of 7 March 2002 on universal service and users' rights relating to electronic communications networks and services (Universal Service Directive),".
8. "Directive 2009/136/EC of the European Parliament and of the Council of 25 November 2009 amending Directive 2002/22/EC on universal service and users' rights relating to electronic communications networks and services, Directive 2002/58/EC concerning the processing of personal data and the protection of privacy in the electronic communications sector and Regulation (EC) No 2006/2004 on cooperation between national authorities responsible for the enforcement of consumer protection laws,".
9. "Regulation (EU) 2015/2120 of the european parliament and of the council of 25 November 2015 laying down measures concerning open internet access and amending Directive 2002/22/EC on universal service and users' rights relating to electronic communications networks and services and Regulation (EU) No 531/2012 on roaming on public mobile communications networks within the Union,".
10. "BEREC guidelines on the implementation by national regulators of european net neutrality rules," BoR (16) 127, August 2016.
11. "Broadband Coverage in Europe 2014 Mapping progress towards the coverage objectives of the Digital Agenda," European Union, 2015, 30-CE-0599698/00-19 SMART 2013/0054, ISBN: 978-92-79-50416-7.